On the Orbit of Spitaler's Comet (VII. 1890).

By Lieut.-General Tennant, C.I.E., R.E., F.R.S.

In No. 3010 of the *Ast. Nach.*, Professor Spitaler expressed an opinion that at its last passage through its descending node this comet passed so near *Jupiter* that its orbit must have been entirely changed. Since then Dr. Hind has made a communication to the Academy of Sciences at Paris, pointing out that the best orbit of the comet did not justify this conclusion.

Soon after seeing Professor Spitaler's remark, I collected such information as was available about the comet, and resolved to examine the question. As an American orbit differed very sensibly from that used by Spitaler, I computed a fresh one from the Vienna Observations of 1890 November 16 and December 13, and that made at the Lick Observatory on 1891 January 12.

From these I deduced the following elements :—

Perihelion passage 1890 October $26^{d}\cdot11874 = 2^{h}\ 56^{m}\ 59^{s}$ G.M.T.

$$\left.\begin{aligned} \pi &= 58^{\circ}\ 15'\ 31''\cdot23 \\ \Omega &= 45\ 08\ 01\cdot32 \\ i &= 12\ 51\ 27\cdot69 \end{aligned}\right\} \text{Equinox of } 1891\cdot0$$

$$\phi = 28^{\circ}\ 12'\ 45''\cdot58$$

$$\left.\begin{aligned} \mu &= 554''\cdot2197 \\ \log a &= 0\cdot5375498 \end{aligned}\right\} \text{Period} = 2338^{d}\cdot46 = 6\cdot4022 \text{ years}$$

Comparing these with the whole of the observations I could find, the result was a very general agreement, showing that the accuracy was far greater than usual in comet observations. The observation at Lick on 1890 December 11 was found to have the time too late by two hours, and this correction was kindly verified by the observer, Mr. Barnard. The whole number of observations was very small, but I deduced the following errors of the Ephemeris founded on the above elements :—

Paris M.T.	$\Delta\alpha \cos\delta$	$\Delta\delta$
1890 Nov. 16·644	$+1''\cdot1$	$-0''\cdot7$
Dec. 6·247	$-1\cdot5$	$-0\cdot3$
Dec. 10·558	$-1\cdot1$	$-3\cdot2$
Jan. 8·074	$-4\cdot5$	$+2\cdot2$
Jan. 12·131	$+0\cdot1$	$-1\cdot0$

On forming equations of condition for correcting the elements referred to the equator, it was evident, as might have been expected, that a change of π could be almost entirely compensated by one of the time of Perihelion Passage; and so, that a change in the Major Axis would be compensated by one in the eccentricity. After making the equations homologous, I adopted the following plan :—

For r and x the unknowns, which are multiples of the corrections required to μ and ϕ, I substituted r' and x', such that $r' = r + x$ and $x' = r - x$; similarly for y and z multiples of the corrections to τ and π' were substituted $y' = y + z$ and $z' = y - z$.

Of course the coefficients of x' and z' were too small to give any trustworthy determinations; but, after forming the normal equations, it was found that when the unknowns, which were multiples of the corrections to the inclination and node, were eliminated the coefficients of x' and y' were both very small, and these quantities also were indeterminate. Four then of the elements are subject to very large corrections.

Eventually I found the following corrections:—

$$\Delta\iota = +1''\cdot91 + 378\cdot5d\mu - 1\cdot434d\phi - 32923d\tau + 4\cdot151d\pi'$$
$$\Delta\Omega = +7\cdot10 + 2081\cdot4d\mu - 1\cdot424d\phi - 23416d\tau + 14\cdot192d\pi',$$

and π requires the small correction

$$\Delta\pi = -0''\cdot53 - 142\cdot3d\mu + 0\cdot174d\phi + 1844d\tau - 0\cdot107d\pi',$$

where π' is the longitude of Perihelion referred to the equator.

By substituting the numerical parts of the values determined for the two retained unknowns in the equations of condition, I found

Sum of errors before correction	in Æ	=	$-6''\cdot1$	in Dec.	$-$	$3''\cdot0$
„ after	„	„	$+0\cdot2$	„		$0\cdot0$
Sum of squares before	„	„	$24\cdot93$	„		$16\cdot66$
„ after	„	„	$15\cdot79$	„		$12\cdot94$

The corrected elements then are subject to the uncertainty resulting from corrections to π' and the other three elements.

$$\left.\begin{array}{l} \pi = 58^\circ\ 13'\ 50''\cdot69 \\ \Omega = 45\ \ 08\ \ 08\cdot42 \\ \iota = 12\ \ 51\ \ 29\cdot60 \end{array}\right\} \text{Equinox of } 1891\cdot0,$$

the others being unchanged.

With these elements there can be no very near approach to *Jupiter* at the time supposed by Dr. Spitaler. Nor is it readily conceivable that the observations will admit such changes as would make a near approach possible. It is remarkable that, where the conditions have been so unfavourable, successive computers have arrived at orbits so near each other as those published.

Measures of Planetary Nebulæ with the 36-inch Equatoreal of the Lick Observatory. By S. W. Burnham, M.A.

During the progress of my regular double star work with the 36-inch equatoreal, I have occasionally examined some of the more interesting nebulæ, and incidentally a few of the Herschel planetary nebulæ. It occurred to me that objects of the latter class would be specially suitable for careful micrometrical measures for the purpose of determining, now or hereafter, whether they have any proper motion in space. I assumed that some of the many observers of nebulæ had already done this for at least the brighter nebulæ of this class, or those where the central stars were bright enough to bring them within the reach of ordinary instruments. I was surprised to find, upon looking over many of the works of the leading observers, that very little, almost nothing, had been done in this field; and I determined, therefore, to measure all the objects of this class when it could be done without seriously interfering with the regular micrometer work on double stars. In the selection of objects classed as planetary nebulæ, I have relied, of course, upon Dreyer's General Catalogue. After an examination of a few of the prominent examples, it is not difficult to say whether or not a doubtful object belongs to the planetary class, since it is entirely a matter of appearance in the telescope, and has nothing to do with the nature of the nebulæ as shown by the spectroscope or otherwise. A central star is usually found in these nebulæ. This is so generally the case as to suggest that as the criterion for classification. Some of these stars are very faint, and can only be seen with a large aperture, and, in a few instances, the large object-glass furnishes none too much light for their accurate measurement with the micrometer. As will be seen from the observations, I have found but two or three nebulæ, which could be otherwise described as of the planetary class, where the central star is wanting. From the wide range of these stars in magnitude, it is fair to infer that the missing stars might be seen with a telescope of still greater light-power. One of these is very far south, and too low in this latitude for any very faint star.

I have also examined Nos. 934, 2440, 2452, 4107, 5144, and 6210 of Dreyer's General Catalogue, and found them more or less lacking in the characteristics of planetary nebulæ. They belong to a much larger and less interesting class of objects, which would be briefly described as small circular patches of nebulosity. Many of the more recently discovered nebulæ, though very much fainter, and usually smaller, are similar in a general way. I have also looked at a number of the so-called "stellar" nebulæ, discovered by Pickering, Swift, and others. These are all, so far as I have examined them, very small, bright, round nebulæ, which in a small instrument would resemble stars slightly out of focus, but do not appear to come within the planetary class.